



DoD High Performance Computing Modernization Program Nurtures Technical Excellence at SSC San Diego*

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High Performance Computing is an extraordinarily significant technology for industry, academia, government, and the military. Computational modeling and simulation have become major contributors to a large number of Director, Defense Research and Engineering (DDR&E) programs within the Department of Defense (DoD). The computational and informational technologies emerging from these mission-critical DDR&E studies are shaping and moving the military and the 21st century warfighter to higher levels of performance and success.

There is a commonly held belief among many that the solution of ever larger and more complex problems is due primarily to hardware improvements. Unfortunately, supercomputers or high performance computers alone do not solve problems. High performance computers need to be combined with complex software and sophisticated algorithms to ensure the innovative applications of this powerful technology.

The development of algorithms is at the very core of computer science. In the last five decades, significant advances in the field of algorithms have been made. For many important problems, the contributions to speedups made by algorithmic improvements exceed even the extraordinary improvements due to hardware. An example of a basic algorithm commonly used in many applications and search engines on the Web is the sorting algorithm (rearranging the elements in a sequence so that the elements are in ascending or descending order). For an arbitrary sequence of n elements, a brute-force sorting method will require order n^2 comparisons, whereas the use of sophisticated algorithms such as quicksort or heapsort will require order $n \log n$ comparisons. Thus, for the case where the input sequence comprises 10^9 elements, the brute-force approach will require order 10^{18} comparisons (on any computer), whereas the quicksort or heapsort algorithms will accomplish the task in the order 10^{10} comparisons. For this specific instance of the sorting application, the speedup achieved through algorithmic improvements alone is about 10^7 fold.

Through continued major funding from the National Science Foundation (NSF) and other federal agencies, great progress has been made in the field of algorithms since the mid-1950s. Typical algorithmic developments for linear equations, least squares, and eigenvalue problems are the routines in the universally recognized Linpack and Eispack packages. These two state-of-the-art numerical computation packages have raised the standards of computational modeling and simulation to exceptionally high levels of performance.

The algorithms in the Linpack and Eispack packages can be viewed as the building blocks by which scientists and engineers are able to piece together software tools that are developed to solve complex and mission-critical problems. Aware of the significance of Linpack and Eispack to the scientific community, Mathworks, Inc. developed a software package called MATLAB that provides researchers with a simple prototyping language and easy access to the essential building blocks included in the Linpack and Eispack packages.

In the last 5 to 6 years, the use of the MATLAB package by the DoD HPC user community as well as by SSC San Diego scientists and engineers has been increasing steadily.

From January through August 2000, the SSC San Diego High Performance Networking and Computing Initiative Group (HPCNIG) hosted seven MATLAB courses attended by 103 SSC San Diego scientists and engineers at no cost to the Center.

In April and May this year, the HPCNIG hosted four more MATLAB courses at no cost to the Center. These courses were taught by a team of professors from Ohio State University through the auspices of the DoD High Performance Computing Modernization Program's (HPCMP) Programming

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Environment and Training (PET) Program. The four courses were two 2-day introductory courses, a 1-day advanced signal-processing course, and a 1-day advanced image processing course. Through these four intensive hands-on MATLAB courses held this year, a total of 90 scientists and engineers have attended, including 15 New Professionals (NPs), a Summer Faculty Professor, and visitors from other DoD centers. The table below summarizes attendance from the four technical departments at SSC San Diego, SPAWAR, NPs, and outside SSC San Diego.

MATLAB Courses	230	240	270	280	SPAWAR	NP	DoD	Total
Two 2-day Introductory	6	1	18	12	2	8	2	49
1-day Advanced Signal	3		6	6	2	5	1	23
1-day Advanced Image	3		6	4	1	2	2	18
Total	12	1	30	22	5	15	5	90

The benefits of the HPCMP PET Program have been significant to the DoD HPC user community and to the SSC San Diego technical community, as evidenced by the participation in the MATLAB courses over the past 4 years. Through these courses, our scientists and engineers, and NPs, have improved on and advanced their numerical computation and signal- and image-processing skills to enable them to solve the increasingly complex and challenging problems encountered in our primary mission areas of command and control, communication, surveillance, and navigation and applied sciences.

All four 2003 courses were held at the truly impressive University of California, San Diego (UCSD) Extension, Sorrento Mesa Training Facility. Through the kind generosity of UCSD Extension and its Computing and Networking Technologies Director, Ms. Tracie Monk, all fees (\$7,200) were waived for the use of the 30-seat Training Facility for the four MATLAB courses held in April and May.

The MATLAB courses attended by SSC San Diego's technical community at UCSD Extension were given by two distinguished and dedicated teachers from Ohio State University's Electrical Engineering Department: Professors Stan Ahalt and Ashok Krishnamurthy. Professors Ahalt and Krishnamurthy were supported in instructions and teaching by Dr. Juan Carlos Chaves, on-site signal- and image-processing lead at the Army Research Laboratories (ARL) Major Shared Resource Center (MSRC), Aberdeen Proving Ground, Maryland.



From left to right, Professor Ashok Krishnamurthy and Professor Stan Ahalt from Ohio State University; Ms. Tracie Monk, Director of Computing and Networking Technologies at UCSD Extension; and Dr. Aram K. Kevorkian (host).



First 2-day Introductory MATLAB course participants with the instructors, Professors Stan Ahalt and Ashok Krishnamurthy.

Above and beyond teaching and instruction, Professor Krishnamurthy assisted an SSC San Diego scientist in writing a MATLAB program to read and sort large amounts of data gathered from a survey at the South Pole.

Dr. Aram Kevorkian initiated and coordinated all efforts among the HPCMP PET Program, UCSD Extension, the instructors from Ohio State University, and the participants.



One-day Advanced Image Processing MATLAB course participants.



Professor Ahalt in the classroom with the first 2-day Introductory MATLAB course participants.

The SSC San Diego HPC Initiative Group is indebted to the HPCMP and its PET Program for the significant contributions made to the technical community at our Center. We greatly appreciate the generosity of UCSD Extension and the valued contributions made by Ms. Tracie Monk. We also wish to recognize the dedicated efforts and important contributions of the instructors, Professor Stan Ahalt, Professor Ashok Krishnamurthy, and Dr. Juan Carlos Chaves. In addition, we wish to extend our sincere thanks to Mr. Mason Colbert, PET Training Technologist/Coordinator at the Aeronautical Systems Center (ASC) MSRC at the Wright-Patterson AFB, for his valued assistance throughout the courses.



One-day Advanced Signal Processing MATLAB course participants with Professor Stan Ahalt (front row on left).



Dr. Chaves (front) and Professor Krishnamurthy in the classroom with the second 2-day Introductory MATLAB course participants.



Second 2-day Introductory MATLAB course participants with Professors Stan Ahalt and Ashok Krishnamurthy, Dr. Juan Carlos Chaves, and the host.

ABOUT THE AUTHOR

Aram K. Kevorkian—Ph.D. in Applied Mathematics and B.Sc. in Engineering Sciences, both from Queen Mary College, University of London, England. From 1968 through 1980, Dr. Kevorkian was a Senior Mathematician at the Shell Research Laboratories in Amsterdam, The Netherlands. From 1980 through 1986, he was a Senior Staff Mathematician and Manager of the Technical Computing Department at GA Technologies, La Jolla, CA. From 1986 through 1987, he was invited as Visiting Scientist at the Mathematical Sciences Department of the IBM T. J. Watson Research Center at Yorktown Heights, NY. From 1988 through 1989, Dr. Kevorkian was the Associate Director of Scientific Computation Support at the Cornell Theory Center, Cornell University, Ithaca, NY. Since 1989, Dr. Kevorkian has served in a number of key High Performance Computing positions at SSC San Diego. From June 1995 until May 1996, Dr. Kevorkian worked at the DoD High Performance Computing Modernization Program Office (HPCMPO), Washington, DC, on the Technical Panel for the acquisition of the four Major Shared Resource Centers. Dr. Kevorkian is currently the Chair of the DoD HPCMPO Metacomputing Working Group and the HPC Outreach Coordinator at SSC San Diego.

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